AMERICAN WELDING SOCIETY

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TENATIVE PROGRAM

ANNUAL MEETING

of the

AMERICAN WELDING SOCIETY

29 West 39th Street, New York, N. Y.

April 22, 23, 24 and 25, 1925

All Sessions Start Promptly as Scheduled

WEDNESDAY, APRIL 23, 1925

Morning

Resistance Welding Committee, H. A. Woofter, Chairman
9:30 a. m. to 12, 10th floor.

Discussion of future plans of Committee. Work on the resistance welding of special metals.

Afternoon

Electric Arc Welding Committee, H. M. Hobart, Chairman
2:00 p. m., 10th floor.

Progress report on investigation to determine certain fundamentals of electric arc welding such as effect of various currents, angles of bevel, number of layers of deposited metal, size of electrode, etc. A large number of test results will be analyzed at this meeting. Progress report of Sub-Committee on Arc Welding of Non-Ferrous Metals.

THURSDAY, APRIL 23, 1925

Morning

Business Session of the American Welding Society
9:30 a. m. to 12, 5th floor.

Program

1. President's Report of Year's Activities.
2. Reports from (a) Finance Committee.
   (b) Meetings and Papers Committee.
   (c) Research Department (American Bureau of Welding).
   (d) Report of Tellers Committee on Election of Officers.
   (e) Introduction of New President.

Afternoon

1:45 p. m., Inspection Trip

The details of the inspection trip cannot be announced at this time. However, arrangements are being made to visit two plants in Jersey City which will be of interest to all members. The inspection trip alone will repay you for your attendance at the annual meeting.

Evening

Fourth Annual Dinner of the American Welding Society
7:00 p. m.

The exact place of the annual dinner has not been announced as yet. Tickets will be at the usual price of $5 per person. Good talent and plenty to eat is promised to everyone. Reservations may be made at once by writing to the Secretary.

FRIDAY, APRIL 24, 1925

Morning

Technical Session of the American Welding Society
9:30 a. m. to 12; 12:45 to 2 p. m., 5th floor.

Symposium

1. Methods of Inspecting Welds.
2. Testing the skill of operators.

Some thirty experts in a wide variety of fields will give a summary of the practices employed in their industry on the above subject. It is hoped thru this symposium to secure authentic information as to the methods now employed in inspecting welds and testing the skill of operators for production work, general repair work, pressure vessel welding, pipe welding, tank welding, steel furniture, etc.

Notes: A buffet luncheon will be served between 12 and 12:45 p. m. to members present. This luncheon is being arranged for the convenience of members and to save time. Tickets may be obtained from the Secretary. The exact price cannot be announced as yet. It will be from $1.50 to $2. The technical session and discussion will be resumed immediately after the buffet luncheon.

Afternoon

American Bureau of Welding Meeting

2:00 p. m. to 3:30 p. m.

Program

1. Progress report of research committee chairmen.
2. Election of officers.
3. Discussion of policies.
4. Appointment of new committees.

Board of Directors, American Welding Society
(including retiring and new members)

3:30 to 6:00 p. m.

Program

1. Review of progress during past year.
2. Introduction of new President.
3. Appointment of Committees (a) Executive.
   (b) Membership.
   (c) Finance
   (d) Meetings and Papers.
   (e) Revision of By-Laws.
4. Plans for the coming year.

SATURDAY, APRIL 25, 1925

Gas Welding Committee, S. W. Miller, Chairman

9:30 a. m., 10th floor.

Progress report on welding of manganese steel. Plans of future work of Committee.

A. S. M. E. CODE ON WELDING OF UNFIRED PRESSURE VESSELS

The Boiler Code of the A. S. M. E., published several years ago, has met with a great deal of success. It has been adopted and enforced by many of the States and has placed the Boiler Code Committee of the A. S. M. E. in a very enviable standing in the eyes of the world as well as in the eyes of the members of their own organization.

After the Boiler Code was published attempts extending over a period of seven years were made to draw up a Code for Unfired Pressure Vessels. Considerable difficulty, however, has been experienced in drawing up a code which would be satisfactory to manufacturers, State inspectors, insurance companies and others interested. One of the factors which has caused a great amount of discussion has been the applications of fusion welding in this field.

The American Bureau of Welding, which was called upon by the Boiler Code Committee to render assistance, recognized the need for scientific data and through a suitable subcommittee drew up a program to secure certain fundamental information needed by the Boiler Code Committee. Unfortunately, only a few of the manufacturers cooperated in this investigation. However, even with this limited cooperation, it was possible to obtain and test forty-eight tanks to destruction at the Bureau of Standards. Based upon the results of these tests, the Bureau of Welding prepared a report which was published by the American Welding Society as Bulletin No. 5.

This bulletin, occupying 156 pages, brought out some very valuable information and reliable data as to the quality of fusion welded joints, which assisted the Boiler Code Committee in building up the Pressure Vessel Code. After repeated efforts and compromises, a code was issued which makes definite provisions for and which recognizes welding to a greater extent than heretofore, but which, nevertheless, is unduly restrictive and incomplete and therefore appears unsatisfactory in the eyes of the welding fraternity. As a definite recognized Code, however, it forms a basis for future adjustments and therefore the American Welding Society, recognizing the urgent demand for a Code, officially approved its issuance in the present form as a step in the right direction by sending the following letter to the Secretary of the Boiler Code Committee:

January 13, 1925.

Mr. C. W. Obert, Secretary,
Boiler Code Committee, A. S. M. E.,
29 West Thirty-ninth Street,
New York.

Dear Mr. Obert:

The Executive Committee of the American Welding Society and the Pressure Vessel subcommittee of our

research department (American Bureau of Welding), after careful consideration of the present proposed code for unfired pressure vessels, are of the opinion that it is unsatisfactory in its restrictions and incomplete in its provisions as far as it relates to fusion welding.

We do recognize the serious need for a code, however, and welcome the work of your committee as the initial step in the right direction, and as it will give a basis for future adjustment.

We know that it is the custom and practice of the Boiler Code Committee to consider and act on any information that may be brought to their attention with a view of modifying their codes. However, there are many who do not understand this, and therefore we would appreciate an official statement from you to the effect that your position will be as outlined above, so we may advise those interested accordingly.

Yours very sincerely,
(Signed) E. H. EWERTZ.
President.

Under date of January 22, Mr. C. W. Obert, Secretary of the Boiler Code Committee, replied as follows:

Mr. Eric H. Ewertz, President,
American Welding Society,
33 West Thirty-ninth Street,
New York City.

Dear Sir:

Your communication of the 13th, in which you express the views of your Executive Committee in regard to the Unfired Pressure Vessel Code that has recently been published in modified form as being unsatisfactory to you in its restrictions relating to fusion welding, was presented to the Boiler Code Committee at its recent January meeting. Your expression of recognition of the serious need of such a code and welcoming the work of our committee as the initial step in the right direction was greatly appreciated by our committee, and I was directed to transmit to you its thanks for not only this courteous expression, but also for the helpful cooperation you have so far rendered in this undertaking.

So far as future cooperation is concerned, the writer was instructed to advise you that it will be just as welcome as in the past and that in return the committee will desire to render all possible assistance and cooperation. If there is any question that you would like to place before the Boiler Code Committee at any time, this courtesy will be granted at any of the monthly meetings that are held (with the exception of the summer meetings in July and August).

It is the writer's suggestion that you feel free to assure any of your members that the Boiler Code Committee is open at any and all times to the consideration of questions concerning the intent and applicability of its codes, and that so far as the American Welding Society is concerned it will welcome its recommendations at any time concerning future revisions or modifications that may appear to be necessary.

Yours truly,
C. W. OBERT,
Secretary to the Boiler Code Committee.

The American Welding Society through its research department (American Bureau of Welding) offers the manufacturers its cooperation in securing further data needed by the Boiler Code Committee at a minimum cost to the individual manufacturer.

DETROIT SECTION ORGANIZED

After a great deal of hard work local representatives of the American Welding Society in Detroit have succeeded in organizing a section in that city. At a dinner meeting held on the evening of February 3d at the Union League Club, President Ewertz presented a review of the benefits of affiliation with the American Welding Society. About 80 were in attendance. Mr. C. A. McCune, National Treasurer, spoke on his experience in aiding other sections to become organized. Mr. H. S. Mann, Vice-President of the midwestern section of the Society, spoke at length on the benefits accruing from organization in any effort and particularly in the welding field. A moving picture was shown illustrating welding and cutting especially as applied to salvaging large castings and reducing large battleships to the point where they could be handled as scrap material advantageously. The following officers were elected to serve for the coming year:

Chairman—H. M. Gould, Assistant General Manager, Dept. of Street Railways, City of Detroit, Mich.

Secretary—C. L. Finch, Detroit Range Boiler and Steel Barrel Co., Detroit, Mich.

Section Activities

Chicago

The January meeting of the Chicago section was held on the 2d. A paper prepared by Mr. G. O. Carter, "Safe Handling and Use of Cutting and Welding Gases," was read and discussed by those present.

Philadelphia

At the January meeting Mr. H. A. Woofter, electrical engineer of the Thomson Electric Welding Co., presented a paper, "Some Applications of Butt and Spot Welding in Modern Industry."

The February meeting of the Philadelphia section will be held on the 16th. Prof. A. S. Kinsey of the Air Reduction Sales Co. will present an illustrated paper on "Molten Metals Under the Oxy-Acetylene Flame."

The March meeting will be held on the 16th, at which time Mr. G. O. Carter of the Linde Air Products Co. will talk on "Construction of Trunk Pipe Lines."

San Francisco

The regular January meeting was held on the 16th. Mr. R. Vane Woods, architect of Oakland, pointed out what the welding industry can do to make it possible for architects to revommend welded pipe connections and welded joints in structural members of large buildings.

Northern New York

Capt. E. P. Jessop presented a paper on Jan. 13 on "Fundamental Elements of Good Welding." The February meeting will be held on the 25th, at which time Mr. A. M. Candy of the Westinghouse Co. will give a talk on "Scrapping of Steel Freight Cars with the Electric Arc."

New York

The February meeting of the New York section will be held on the 16th. Mr. J. F. Crowe, engineer in charge apparatus research and development department of the Air Reduction Sales Co., will present a paper, illustrated with lantern slides, on "Some Experiments with High Purity Oxygen." This will be followed by a demonstration of liquid oxygen by G. Van Alstyne and commercial oxygen testing by F. P. Gross, Jr., both of the Air Reduction Sales Co.

List of New Members for the Months of October, November and December

CHICAGO

J. B. Dunlop (B), Salesman and Service man, Oxweld Acetylene Co., 3642 Jasper Place, Chicago. Proposed by Geo. F. Schmid.

Fred B. Johnson (B), Sales Engineer, Oxweld Acetylene Co., 3642 Jasper Place, Chicago. Proposed by Geo. F. Schmid.

Robert E. Longwell (B), General Foreman, Structural Shop, Link Belt Company. (Res.) 7634 Vernon Ave., Chicago. Proposed by Thomas Jones.

Charles O. Watson (C), Salesman, Gibb Instrument Co., 551 West Van Buren St., Chicago, Ill. Proposed by Stewart Plumley.

Fred A. Ernst (D), Welder. (Res.) R. R. 2, Box 287, Station E, Louisville, Ky. Proposed by Guy W. Bottorff.

CLEVELAND

R. B. Fehr (A), Development Engineer, Rail Welding & Bonding Co., Cleveland, Ohio. Proposed by H. L. Whittemore.

John A. Bickel (B), Production Manager, The Massillon Steel Joist Co., Massillon, Ohio. Proposed by C. J. Holslag.

DETROIT

Fred Crampton (D), Student. (Res.) 6172 Commonwealth Ave., Detroit, Mich. Proposed by H. H. Heckman.

Percy J. Storey (D), Cutter. (Res.) 1582 Richton Ave., Detroit, Mich. Proposed by H. H. Heckman.

NEW YORK

J. R. Dawson (B), Metallurgical Engineer, Union Carbide & Carbon Laboratories, Thompson Ave. and Manley St., Long Island City, N. Y. Proposed by S. W. Miller.

E. W. Ryder, Jr. (B), Sales Representative, Morris, Wheeler & Company, 39 Cortlandt St., New York. Proposed by J. W. Meadowcroft.

H. B. Christie (C), Sales Manager, Weldox Equipment Co., 359 West Fifty-second St., New York. Proposed by A. F. Keogh.

WESTERN NEW YORK

C. E. McCoy (B), Superintendent of

Plant, Kaustine Company, Perry, N. Y. Proposed by C. D. Miller.

E. S. Hebeler (C), Superintendent, Allan Mfg. & Welding Co., Inc., 726 Washington St., Buffalo, N. Y.

E. J. Weitzman (C), Engineer in charge of welding, Niagara Electro Chemical Co., Niagara Falls, N. Y. Proposed by G. W. Swan.

C. Schacht, Jr. (D), Foreman, Welding Department, Niagara Electro Chemical Co., Niagara Falls, N. Y.

A. J. Schulenberg (D), Electric Arc Welder, Allan Mfg. Welding Co. (Res.) Genesee St. Forks (Erie Co.), N. Y. Proposed by G. W. Swan.

PHILADELPHIA

Edward Evans (B), Manager, Fence, Culvert and Wire Products Department, Horace T. Potts Co., East Erie Ave. and D St., Philadelphia, Pa. Proposed by J. W. Meadowcroft.

A. A. Ziegler (B), Manager of Sales, Morris, Wheeler & Co., Thirtieth and Locust Sts., Philadelphia, Pa. Proposed by J. W. Meadowcroft.

George C. Kahmar (C), Foreman, American Pulley Co. (Res.) 141 W. Luray St., Philadelphia, Pa.

Alan C. Walker (C), General Factory Foreman, American Radiator Co. (Res.) 4524 Smedley St., Philadelphia, Pa.

John N. Purviance (D), Welder. (Res.) 3023 West Coutter St., East Falls, Philadelphia, Pa. Proposed by J. W. Meadowcroft.

SAN FRANCISCO

S. E. Wise (D), Electric Welder, Iron & Steel Contracting Co., 215 San Bruno Ave., San Francisco, Cal.

SOCIETY

A. E. Reuss (C), President, The General Iron Works Company, Cincinnati, Ohio. Proposed by W. Spraragen.

W. V. Cooper (D), Machinist and Acetylene Welder, Homochitto Lbr. Co. (Res.) Box 92, Bude, Miss.

Floyd A. Falls (D), Oxy-Acetylene Welder, C. B. & Q. R. R. (Res.) 412 Larmie Ave., Alliance, Neb.

EMPLOYMENT SERVICE BULLETIN

Positions Vacant

V-21. Welder wanted with at least five years' experience in job welding shop, principally automobile work; must be expert on cast iron and steel, expert on preheats, who has welded cylinders cracked internally, built up worn valve seats, etc. Knowledge of aluminum welding, chassis straightening, electric welding and boiler work, desirable but not necessary; salary to start, $50.00; location, New York; chance for foremanship. Write all details just where you worked and what you did for the past ten years in confidence.

V-23. Assistant Executive. Opportunity for real live wire to connect with general repair welding and radiator works in fast growing city in north New Jersey. Established eleven years. To branch out owner needs reliable assistant executive. Capital not essential. Best location and most up-to-date equipment. Man of good personality and some experience can make unusual connection as active partner. Give particulars of past experience, age and monthly income expected.

V-24. Desires services of a young man who is familiar with welding shops in metropolitan district to sell welding rods and accessories on a commission basis with very good prospects for future development.

V-26. Wanted, a good man to sell welding and cutting apparatus.

Services Available

A-31. Acetylene Welder. Has had 15 years of experience as a welder with good all around experience in the following lines: shipbuilding, boiler and tanks works, railroad, machine shop and steel mills. Have also worked during the past 8 years in same fields as electric welder. Am at present employed as an electric and acetylene welder. Have also acted as welding instructor in the British Navy. Am 35 years of age.

Electric Arc Welding in the Steel Industry

By W. L. Warner†

The art of welding is old, but electric arc welding as a science is a comparatively recent development within the past two decades. Heat is generated by an arc which is formed by a gap in an electric circuit. The heat of the arc causes fusion to occur between the parts to be welded and metal is generally added from an external source to complete the weld. Certain kinds of metal can be deposited with the electric arc under suitable conditions. Sheet steel 1/16 in. thick or a break in a large casting may be welded with the electric arc. In either case the capability and experience of the operator affect to a great extent the quality of the finished job.

In the steel mill the opportunities for utilizing the electric arc in repair work and for salvaging worn parts are very numerous. They are more numerous, in fact, than we realize. The product is steel and steel machinery is the necessary equipment for this manufacturing process. Breaks will occur under the severe service required, and certain parts are very quickly worn sufficiently to require replacement or repair. In most cases, it is of prime importance to avoid delay or inactivity, as idleness costs real money in a steel mill. The shutdown of one part of a mill means a cessation of activities of the whole mill.

However, it must not be supposed that all machinery parts are allowed to wear out before replacement. In fact, whenever excessive wear on any part is noticed a new part or one previously repaired by welding may be inserted, thus avoiding undue stresses in various parts of the machinery caused by a sudden failure of one part. Practices vary, however, in different respects in the various steel mills throughout the country.

In the brief discussion given above, the writer does not mean to imply that failures of parts of a steel mill are necessarily repaired on the spot by electric arc welding or that the savings effected by the electric arc are primarily achieved in this way. In fact, many repairs which are made by electric welding require a longer time than would be required to put a new part in the place of the one which is broken or worn out. But, if new parts were inserted for broken ones every time failure occurred, the cost would be enormous. However, broken parts can be salvaged with the electric arc in the welding shop and be put back in service again with a cost much less than the cost of a new part.

Even if it were possible to carry a sufficient stock of new repair parts to keep the mill in continuous production, the cost of replacement would be staggering. The electric arc welding process

†Industrial Engineering Department, General Electric Co.

will cut maintenance cost tremendously and in varying degrees depending on the class of work done.

Spindles

The most universal repair which is at present done with the electric arc is the building up of worn wobblers on mill pinions and spindles. In some welding shops the deposited metal is hammered as each layer is added, thus eliminating some of the internal stresses. Sometimes the outside layer is put on of manganese steel so that a manganese content of probably from 10 to 12 per cent is obtained. When welded in this way the length of service obtained from the repaired wobbler is often greater than the

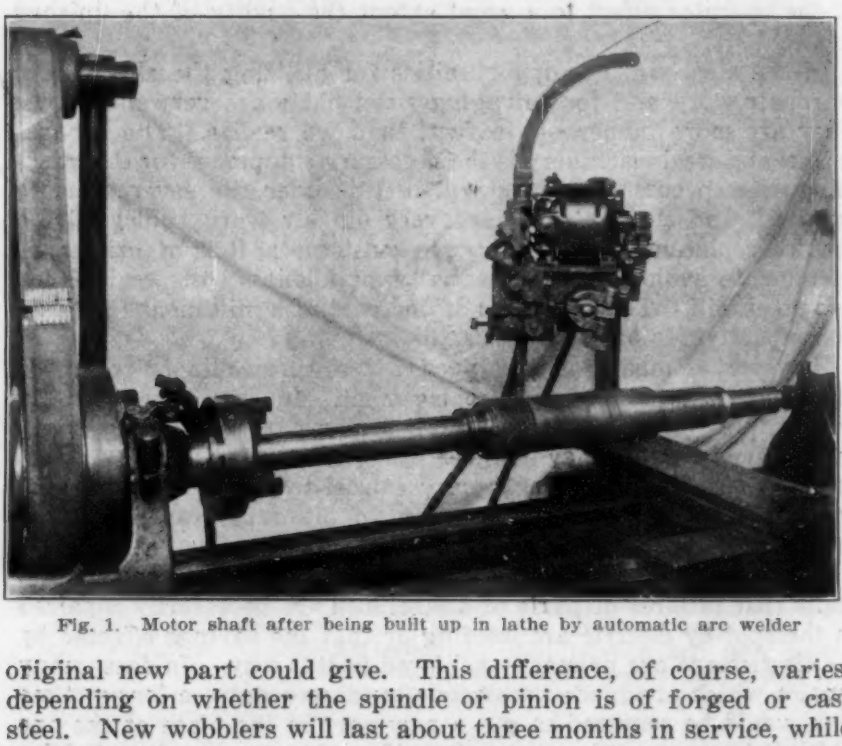

Fig. 1. Motor shaft after being built up in lathe by automatic arc welder

original new part could give. This difference, of course, varies, depending on whether the spindle or pinion is of forged or cast steel. New wobblers will last about three months in service, while welded wobblers often last over six months. This saving effected by welding over replacement by new parts may be considered in a different light when it is known that the repair of worn wobblers by welding costs between $30 and $100, while the cost of a new spindle or pinion is from $1000 to $2500. As an illustration, an actual case may be cited in which a spindle 22½ ft. long and 16 in. in diameter at the center was repaired by arc welding. The jaws of the wobblers were 8 in. deep, 8 in. wide and 12 in. long and were worn on each side because the spindle had been reversed while in service. In this case, therefore, 16 jaw sides were built up and approximately 85 lb. of electrode material was used. The

total cost was about $51, while the cost of a new spindle would be about $2000.

Let us consider the table rollers. There is a considerable saving effected not only in the manufacture, but also in the maintenance of the cast steel roll. Blowholes occur in the roll surface or defects exist in the bearing surface. Either the metallic arc or the carbon arc is used for filling up these blowholes. While in service the roll pinions sometimes crack, some teeth break out, or the piston breaks loose from the roll entirely. These types of failures are easily and cheaply repaired by electric arc welding. In some cases table roller bearings when built up by arc welding have lasted about six months longer than new ones.

Sheet Mill

One instance of the savings effected by electric welding may be cited in the hot sheet mill where several cast steel roll housings had broken and were successfully welded with the electric arc. These housings weigh from 15 to 16 tons and cost about $3000 when new. The average cost of repairing the fractures was about $500 each, and in one case it was stated that 12 of these housings in one mill are welded and in service at the present time. These housings have now been in service on an average of about 2½ years. In this case alone, the use of arc welding effected a clear saving of approximately $30,000. This amount certainly more than paid for the first cost of the welding apparatus required to do the work.

In the hot sheet mill, the roll train rider ears slide in guides which confine the rider to an up and down motion. The ears wear thin after a length of time and must be thrown away, unless the original thickness can be restored. This has been successfully done with the electric arc. On the average a pad of metal about ½ in. thick must be deposited on each ear. The ears are about 8 in. long and 3 in. wide. Between 3 and 4 of these riders can be welded in 10 hr., using between 11 and 13 lb. of electrode material. If the deposited metal is built up exactly to size and hammered thoroughly, no machine work is necessary as a hard, smooth finish may be obtained without machining. If machining is resorted to usually about 6 riders may be completely machined in two hours. The average total cost of making the repairs necessary is about $3.25 per rider. This figure will vary, depending on the amount of wear and the size of the rider ears. This is a great saving.

In the hot steel mill also there are annealing furnaces used for bringing the sheets up to the proper temperature for rolling. The sheets are passed slowly through the furnace on water-cooled disk rollers, which are slowly turned by machinery external to the furnace so that the sheets of steel are thoroughly soaked with heat. It has been found that the disk rolls frequently burn through because of air pockets which have formed inside of the disks due to their rectangular cross-section. In order to avoid this condition one welder devised a new type of roll made of standard pipe made

up in a spiral form with the connections welded. The rolls cost about $25 each complete. Several furnaces have been equipped in this way and are in satisfactory operation without any failures to report, although this operation has not been of sufficient length to prove conclusively that the new rolls are an improvement on the old ones. These new rolls are a distinct departure from the former type of disk rolls, and it is believed that due to the nature of the construction, these rolls will long outlast the previous type of disk rolls.

Another piece of machinery which sometimes breaks is the plate

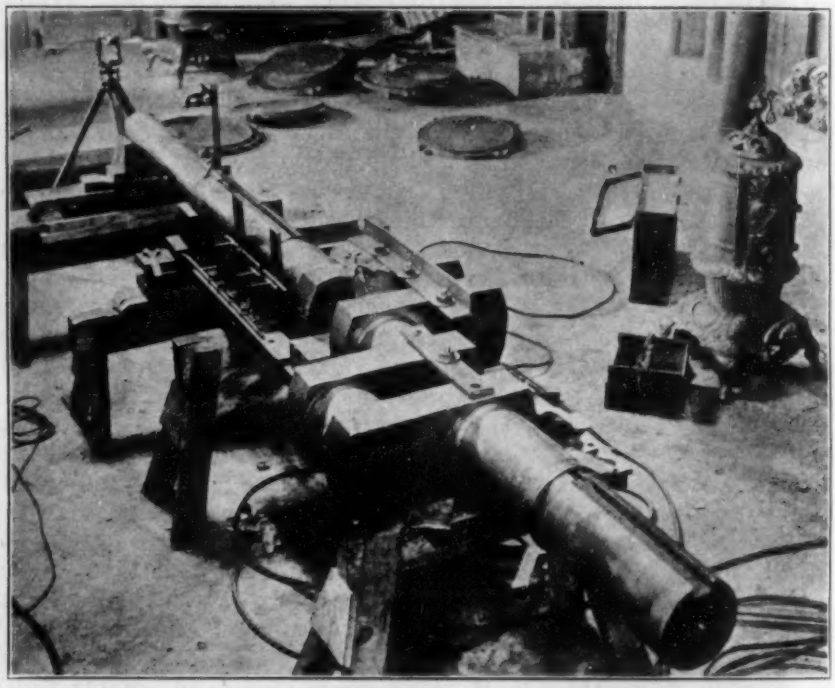

Fig. 2. Broken crankshaft clipped out, lined up and ready for electric arc welding

shear in the sheet mill. The writer has seen a large shear on which one end of the head was cracked for about 14 in. This crack was welded with the electric arc. The shear is now in continuous operation with no further signs of failure.

In the strip mill we find the electric arc used for building up the bearings or repairing cracks in table rollers. These welded rollers are stated to give over 6 months longer service than new rollers. In some cases the strip mill guides, whether of rolled, forged or cast steel, are welded throughout.

Blooming Mill

Some parts of the machinery customarily found in the blooming mill, bar mill or structural mill are economically repaired with the

use of electric arc welding. Certain parts, such as wobblers or table rolls, have been mentioned. The gear pinions for the manipulators or the strip mill pushers are easily and economically repaired and put back into service. In one instance a 15-toothed gear has had 8 teeth built in by arc welding and is in service at the present time. The screw-down for the blooming mill sometimes needs a thread built up or some of the teeth in the gears have broken out. Repairs of this nature are easily and quickly made with the electric

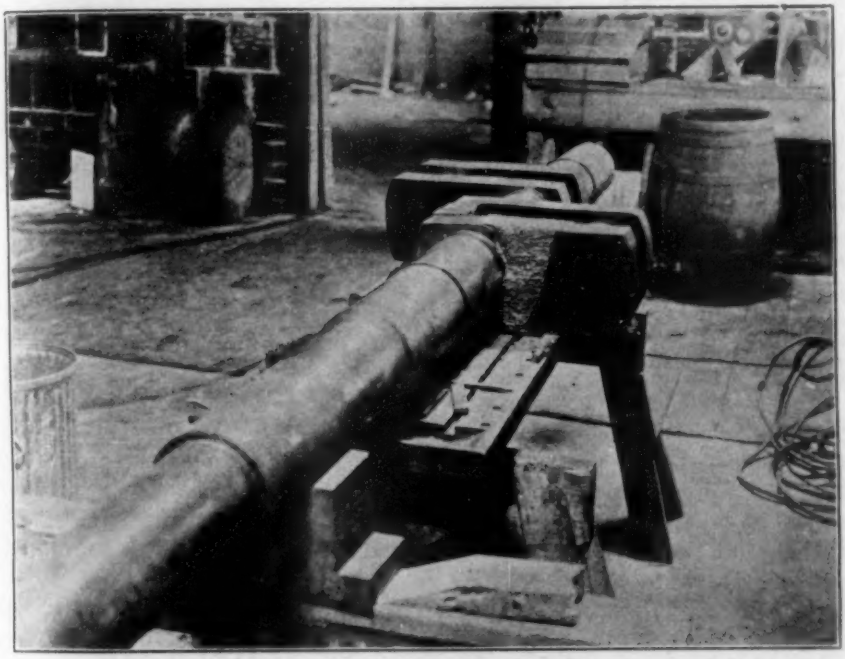

Fig. 3. Broken crankshaft repaired by electric arc welding

arc and the repaired part is ready for further service instead of the scrap pile.

Sometimes a main roll bearing cracks or the lugs are broken off. Instead of scrapping the bearing, repairs can easily be made with the electric arc and the bearings may be put back in service. In one instance a bearing lug was welded to the bearing and a crack in the bearing repaired at a cost of about $9. It was stated that a new bearing costs between $350 and $400. Cracked bearings, housings and spindle couplings may also be returned to service in a similar manner.

The modern trend toward electrically driven rolling mills and accessories has necessitated a large number of small motors for operating steel mill accessories. In most cases these motors are situated in the mill adjacent to the apparatus operated by them and are subject to very severe service. Usually there is no careful

inspection of these motors maintained, except to take up the bearings sometimes when the motor vibrates excessively. The mill operates until a motor fails, either due to a worn commutator, worn shaft, or a burned out armature or other causes. Perhaps the bearings need rebabbitting or the shaft is worn so that the bearings cannot be tightened any more. At any rate, the motor is replaced by a spare and the mill goes on rolling steel. But what happens to the motor which has just been replaced? It is sent to the electrical repair shop.

In the repair shop the motor is dismantled, and if the armature is burned out or the field coils injured, new windings are put in. Sometimes only the shaft is worn and a new one is inserted or the old one is repaired by depositing metal on the worn spot with the electric arc. The rebuilding of worn shafts by the automatic arc welding process is a simple, everyday proposition, as shown by Fig. 1.

The welding and machining may also be done without removing the shaft from the armature. This application of arc welding represents a considerable yearly saving not only by salvaging the worn shafts, but also by speeding up the repair work, which eliminates the necessity of tying up a large amount of money in extra spare parts.

In the case of the steam-driven rolling mill the crank shaft of the motor might break, as shown in Fig. 2. The broken crank shaft completely repaired with the electric arc process is shown in Fig. 3. While a break of this character is probably a rare occurrence, nevertheless the use of the electric arc welding will save considerable time and money should the need arise. The many details which must necessarily be considered are partially illustrated in Fig. 2. This shaft must necessarily be very carefully lined up prior to welding, and it is absolutely essential that this accurate alignment be maintained during the welding and until the weld has cooled.

Foundry and Furnaces

In the open-hearth furnaces, foundry and blast furnaces, arc welding is of valuable assistance. Water coolers for the open-hearth furnaces are constructed in some cases by simply welding a strip of sheet steel of the proper width across the front of a structural channel, thus forming a water tight chamber of approximately a rectangular cross-section. Small pieces of sheet steel are welded to the ends closing the openings. Pipe connections are welded into the ends so that water can be circulated through the chamber. This method of construction lends itself readily to any size of water cooler which may be required.

It sometimes happens that the peel of the charging carriage breaks. A new peel may be inserted and the broken one repaired in the welding shop. Breaks in the gears or travel mechanism of the charging carriage may be also repaired by welding. Some-

times the doors of the open-hearth furnaces develop cracks, which are easily and quickly repaired with the electric arc.

For repairing defective castings in the foundry the electric arc is of great assistance and many thousands of dollars are saved each year by its use for filling blowholes and building up undersized parts. The electric arc also offers many inducements for cutting up steel scrap for charging the cupola or removing risers from steel castings.

Transportation System

The maintenance of satisfactory transportation facilities between buildings and departments demands a certain amount of study. Most every steel plant maintains a more or less complete steam railroad system for moving materials from place to place. The locomotives require periodic inspection and repairs. New flues must be inserted or a new flue sheet put in. A crack in the firebox must be repaired. Perhaps there is a broken frame to be repaired. Electric welding will make the necessary repairs with the least expenditure of time and money. Worn motion parts may be easily built up to the proper size with the electric arc. New journals may be restored or the old ones repaired. The electric welding arc is indispensable in the locomotive shop. Frequently repairs can be made without the necessity of any dismantling, thus shortening the time of idleness of the locomotive.

Track maintenance and upkeep of yard cars also are of some importance in a steel mill. Switch points, cross-overs and frogs are easily built up to the proper size. A rod of about 12 or 13 per cent manganese content is sometimes used in order to obtain a wearing surface which will resist abrasion. After the welding is completed grinding is sometimes resorted to in order to smooth up the wearing surface. Rail bonds are quickly and easily attached by electric arc welding. Car couplings and journal boxes are sometimes repaired and put back in service without any appreciable cost. Worn journal boxes may be relined or worn spots reinforced by putting on a steel plate in some cases.

Pipe Lines

Oftentimes leaks occur in water or steam lines which can be quickly and conveniently repaired by electric arc welding. Welded pipe lines can be installed more cheaply and easily than any other type of jointed pipe. In one case 400 ft. of 6-in. steel pipe for a water line carrying 400-lb. pressure was successfully installed in a steel plant. The pipe lengths were 20 ft. and the thickness of wall was $\frac{3}{8}$ in. Each joint was beveled at 45 deg. and welded with the electric arc. The cost per joint was approximately $1.55.

In the foregoing discussion the writer has attempted to enumerate the various applications of electric arc welding which may be found in and around the average steel plant. There are probably

some which certain ambitious welders have developed that are not mentioned here, but in the main the great use to which the electric arc welding process is being put every day in the steel mill shows that electric arc welding does satisfy a universal demand. This process has been termed "The ironworker's needle and thread, a universal saver of time, labor, money and materials."

In addition to the many applications of electric arc welding in the steel mill where steel is made, there are many interesting instances where the process may be advantageously used in the fabrication of steel products.

Fig. 4 shows the arc welded pipe connections between the gas

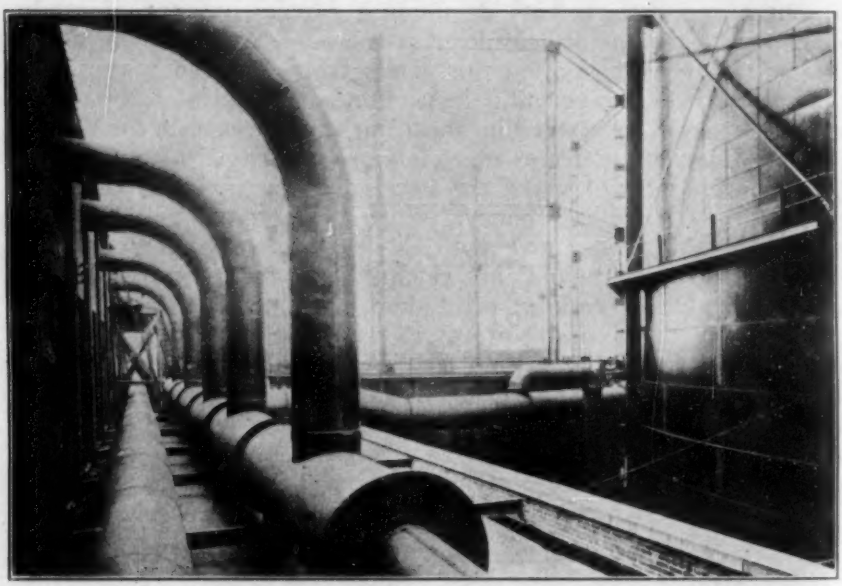

Fig. 4. Arc welded offtake connections from water gas machines

generators and a collector header at a municipal gas plant. The upright pipes are 20 in. in diameter and the header is 28 in. in diameter. A considerable amount of this type of construction is sometimes used in gas generating plants.

There are several reasons why the electric arc welding process should be considered for general repair work in the average steel plant.

First, the use of electric arc welding eliminates the necessity of tying up large amounts of working capital in new spare parts.

Second, the use of electric arc welding decreases the cost of replacement to a very great extent. In many cases the wornout part can be rebuilt at a fraction of the cost of a new part and the amount of service obtained from the part so rebuilt will be equal to and often greater than the amount of service obtainable from a new part.

Third, the use of electric arc welding eliminates considerable delay in making repairs or replacements.

Fourth, the electric arc welding process is successful when handled by an experienced welder operator.

In general, the writer has endeavored to show the wide range of opportunities offered for using electric welding. While the possibilities of electric arc welding are now becoming recognized by the steel industry to a certain extent, yet there is still room for advance. The expansion of the process depends to some extent upon the supply of competent and experienced operators. Good sound, strong welds are required because of the heavy service which must be experienced in a steel mill. Every failure means a loss of money and the executive in the steel industry is rather cautious. This caution must be replaced by confidence not only in the welding process, but also in the welder himself. Eventually this condition will be realized.

Safe Handling and Use of Cutting and Welding Gases*

G. D. CARTER†

Gases for cutting and welding naturally fall into two classes, namely: (1) fuel gases, and (2) oxygen. Fuel gases, such as acetylene, may be generated at low pressure in the plant or brought in cylinders at high pressure in dissolved form, while other less commonly used gases may be purchased in liquid or gaseous forms in cylinders. Approved practices for generating and handling fuel gases have been set up by the Regulations of the National Board of Fire Underwriters, so there is little or nothing to be said on their safe handling and use which has not already been said and placed on record many times.

The same can hardly be said with regard to oxygen. Its widespread use, for example, about the furnaces in steel plants and foundries, involves the assumption of certain definite risks not common to other industries. Therefore, the time available may be spent with profit if we note some of these hazards and describe simple and feasible ways of avoiding most of them. First we will relate what is generally accepted as approved practice in handling oxygen cylinders.

Receiving and Storage of Oxygen Cylinders

Steel plants and foundries in general are what may be called "large consumers" of oxygen. Their requirements run from a few hundred cylinders per month to as many per day. Therefore, the

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problem of receiving the supply and accounting for the cylinders is worth special consideration by the storekeeper.

On receipt of a shipment of cylinders the careful warehouseman will examine them and set aside any which show evidence of rough handling. Leaky valves can be detected by filming the outlet with soapy water and watching for bubbles. A cylinder with damaged threads on the outlet nipple should also be set aside and the oxygen manufacturer notified.

It is a hard job to prevent truckmen and laborers from dropping cylinders out of the car or truck. Despite the fact that they are made of highest quality metal they should not be mis-handled, since they contain gas at very high pressure, which seeks flaws unceasingly. Common sense alone signifies reasonable caution. One good way to avoid carelessness is to build storage platforms car-body high. Since oxygen is not combustible, exposive or lethal, most of the precautions advocated about the handling of oxygen cylinders (such as keeping lights and fires away) are primarily established because all cylinders look alike to some men. If they are careful with oxygen when it isn't strictly necessary, they will probably be careful with acetylene or other fuel gases, where it is absolutely necessary.

Call Oxygen By Its Right Name

In this connection a thought may be interjected with all the emphasis we can command, and that is this: Call Oxygen by Its Right Name. When you mean oxygen, say "Oxygen."

During the last twelve months there have occurred three or four accidents caused by foolishly using a cylinder of oxygen to impose head pressure on an oil tank feeding burner or pre-heating torch. This would be a hazardous proceeding even on a clean, empty tank, for the pressure in a fresh cylinder of oxygen (2000 lb. per sq. in.) is sufficient to overstrain and probably rupture the average storage tank. When the interior of the tank is greasy or oily the practice usually causes immediate disaster, for the oily substances take fire spontaneously in contact with the oxygen, developing so much heat and pressure that an explosion and fire result.

Such accidents may be in part due to the fact that many welding operators, foremen, and even purchasing agents, refer colloquially to a cylinder of oxygen as a "cylinder of air" or a "tank of air." Perhaps some of them really think that it contains compressed air and that it can be used interchangeably with the air supply from a compressor for pneumatic hammers, drills and other tools. This is far from the truth!

This confusion of ideas is probably due in part to the corporate names of the leading manufacturers of oxygen. However, these organizations never refer to their product as anything but "Oxygen." Each is shipped with a tag or label showing the word "OXYGEN" in large type. Rough handling in dirty places may

obliterate and mutilate this lettering; nevertheless, users of compressed gases cannot be too careful to use the correct name at all times, and insist upon their workmen and supervisors doing the same.

"Oxygen is not air," it is oxygen. Acetylene is not "gas," it is acetylene. The assumption that oxygen and air are synonymous terms is particularly dangerous. Like steam, water or electricity, oxygen is a docile servant when properly used.

Store In a Safe Place

Once the properties of oxygen are understood it will be known that although it will not burn, it will aid mightily in burning anything else which will. For that reason cylinders should not be placed near stores of rope, tar, building paper or paint. Oil and grease, of course, should be kept religiously away—a most important point that does not need to be stressed in detail before the present audience.

Moderate changes in temperature involve no hazard for oxygen cylinders. Therefore it is quite all right to store cylinders on an outside platform, provided they are sun shaded and protected from tampering by curious individuals. This is the chief consideration for isolated stores—say, on an ore dock or in a scrap yard, or in a mill building. A small shed likewise will suffice. Make a skeleton of second-hand structural shapes or pipe, a roof of corrugated iron, sides of heavy fencing welded on, and a locked door. Locate this where it is accessible for cars or trucks, yet where there is no danger that it will be pierced by a flying chunk of steel or the cylinders endangered by splashes of hot metal or slag.

Transportation of Cylinders

Oxygen and fuel gases are used in such quantities about a steel plant that a definite delivery service should be established. This is not only cheaper, but better, than sending a laborer and a wheelbarrow. He will loaf on the job and the load will be spilled frequently. Furthermore, a regular truckman can be instructed and depended upon to handle the cylinders in a careful manner and with oil-free hands.

Deliveries about a mill building are often made by crane. Should a cylinder of oxygen be dropped hard enough to rupture or puncture it, some damage might be done while threshing about before the gas escapes. Therefore, handling with a magnet or by chain slings should be prohibited. Load the cylinders into a "boat" or a box with sides, or provide a special carrier such as illustrated in *National Safety News* for January, 1923.

For ordinary jobs of cutting and welding, located here and there throughout a mill, a two-wheel truck with cylinders chained in should be bought from an apparatus manufacturer. Beyond the obvious fact that delicate regulators and valves will be better protected, this truck elevates the cylinder from a nuisance to be kicked

out of the way to a real tool to be treated with due consideration. Much hazardous mistreatment of cylinders by workmen undoubtedly is due to the fact that their foremen seem to think that a cylinder is of no account and a welding outfit deserves no more care than a sledge.

Oxygen for Tap Holes

A great amount of oxygen is now used alongside blast furnaces, steel furnaces and ladles of molten metal, for opening tap holes through which rush streams of white hot metal. This use of oxygen involves certain additional risks.

An oxygen lance is a simple form of cutting blow-pipe. It is best adapted to piercing holes in large masses of iron or steel and cutting large sections. This metal may be clean or very dirty, hot or cold.

It is absurdly simple. Too often it is found in operation stripped to its bare essentials; that is, consisting of nothing more than a length of ⅛ or ¼-in. steel pipe, connected to a cylinder of oxygen with a piece of common hose. In such form it requires two men to operate it—one handling the lance, with the other opening the cylinder valve. This scheme has nothing but parsimony to recommend it, because operation without proper attachments has caused several bad accidents and is very wasteful of oxygen as well.

Therefore, safety, convenience and economy demand certain attachments as indicated. A heavy duty regulator should be used to control the pressures in the hose. Such regulators are designed to pass a heavy flow of oxygen without so-called freezing. In order that the supply may not fail at a critical moment, it is desirable to hook up at least five cylinders to a manifold.

It should be repeated that several accidents have resulted from a failure to provide oxygen pressure regulators for this work, even in plants where ordinary cutting and welding practices are quite good. It is easy to see how these accidents occur. If for any reason the lance pipe becomes plugged, pressure in the hose and pipe mounts to rupturing proportions. The way to avoid this is simple: insist on the use of a regulator and then insist on careful attention and frequent inspection.

Despite what many furnace men say, oxygen pressure on the line should not be high; usually 60 lb. will be ample. In fact, volume is more important than pressure. Pneumatic hose may be used. Be sure it has not previously been connected to air tools and is never loaned to a riveting crew to become oily and greasy. Large area, especially at couplings, is very desirable. Do not use wire-wound hose, because if it bursts it flies into fragments.

The bent piece of 1-in. pipe serves as a handle, allowing the operator to stand to one side of the stream of sparks, blown back out of the hole. (Goggles and asbestos gauntlets are obvious essentials.)

The lance pipe must also be free of oil or grease and have ends

with easy running threads. Each length should be equipped with the usual sleeve connection. Freedom from oil or grease can easiest be insured by placing the pipe in a pre-heating furnace and keeping it at a red heat for a few minutes.

Hazards of Furnace Work

It is obvious that close proximity to molten iron and steel is not the safest place in the world to keep oxygen cylinders. In the first pace, most cast houses and tapping platforms are somewhat inaccessible and many handlings are required before the cylinders finally arrive at the scene of operations. In the second place, there is none too much room available at the point where the oxygen is needed—in other words, cylinders are liable to be very much in the way. Lastly, the surroundings are hot and there is danger that a splash of metal or slag may strike a cylinder, causing the oxygen to burn through the cylinder wall and escape with a violent "kick-back." (Iron "kindles" in pure oxygen at approximately 925 deg. C. a cherry red heat.)

For these reasons it is advisable to bring the oxygen to the furnace in some other way than by cylinders. We shali describe this modern method at length later in this paper. However, the large majority of steel plants still use cylinders close to the furnace. For such conditions the following remarks apply:

It should be apparent that the cylinders serving each furnace should be inclosed in a sheet metal cupboard, affixed to the wall in the shelter of some building column. Regular delivery service by careful, experienced men should be instituted. Rigid inspection should be given all equipment at frequent intervals—hose should be cut back a couple of inches at each end, examined for deterioration, and couplings securely replaced; manifolds and regulator tested for leaks and gages for accuracy; lance pipe watched for grease and oil. Above all, the men should be observed in action and cautioned against any carelessness or reckless disregard of common rules of safety.

However, it is many times impossible to find safe storage for oxygen cylinders near the tap-hole of open-hearth furnaces. For such a condition the American Rolling Mills Company has devised a traveling oxygen supply. Cylinders are loaded into this buggy from the bottom, rest on cradles and are held in place by the end gate. A little shelf attached to the handles supports the manifold and pressure regulator, all of which is guarded from a passing blow by sheet metal and wire screening. This equipment can readily be wheeled up to the furnace breast when tapping is necessary and removed promptly to a safe haven when it has served its purpose.

Pipe Lines for Oxygen Supply

Unquestionably a safety engineer can do much to reduce the risks attending the proximity of oxygen cylinders and large quantities

of molten metal. Nevertheless, the ideal would be to keep them as far apart as possible. Fortunately this ideal can be approached by installing an adequate pipe line system, leading from manifolded cylinders at a central point to the various consuming stations. This scheme has given great satisfaction at railway shops and large manufacturing plants for some years and therefore a system can be installed with assurance of permanent satisfaction.

Nor is the cost so very high. A recent study of a typical small plant, possessing two blast furnaces, 10 open-hearth furnaces and the necessary rolling mills, showed that 3500 ft. of pipe line (the longest branch of which was 1200 ft.) would satisfactorily cover the plant, so outlets could be placed within 50 ft. of more than 90 per cent of the oxygen consumption points. This expense was estimated as follows:

Housing and platform	$1,000
Manifolds and regulators	1,000
Pipe: 3500 ft. at 50c	1,750
Valves	400
	$4,150
The operating costs would be:	
Interest and depreciation 25 per cent....per year	$1,000
Extra labor for attendance	1,000
Total	$2,000

The cost of handling individual cylinders in that mill was estimated at 25 cents each, so that the above yearly expense would pay for handling 8000 cylinders per year by hand. This amounts to 650 cylinders per month—the approximate consumption of their open-hearth department alone.

On this basis only it was good business to pipe the plant for oxygen. As a matter of fact, experience shows very large economies in oxygen consumption when furnace tapping is done with proper manifolding system. Add to this the real value of the safety insurance and the brief for the oxygen pipe line as an economical method of handling fairly large quantities of oxygen is complete.

Oxygen Manifolds

Each plant is a study in itself, nevertheless some of the details of a typical installation may be given.

The central welding shop will probably be favored for the location of the manifold. It will ordinarily be at or near the boiler shop and conveniently situated for the furnace departments and mills. The plant may be served, therefore, with not too great length of piping. The shop is also convenient to railroad track or trucking roadway, so cylinder handling is reduced to a minimum. Fur-

thermore, the repair man who cares for welding equipment is an ideal person for handling the cylinders to and from the manifold, and he ordinarily will have plenty of time to do the work.

The manifold room should have storage space for a minimum carload of oxygen cylinders (say, 200 at least). Its floor should be car-body high. An ample loading platform should be provided. Of course, it is separated from any acetylene generator or fuel gas stores by a fire wall. It should be steam heated to prevent regulator trouble in severe winter weather.

No attention need be given the oxygen supply at night if a sufficient number of full cylinders be hooked on the line after the day shift quits. If a full 12 hours' supply is available during the nighttime—when consumption normally would be at a low rate—an ample margin will be available. In the typical small steel plant under discussion two 20-cylinder manifolds, each with its own regulators, would be sufficient. These should be joined to headers and have necessary valves and by-passes so any bank of ten could be cut off the main line at will, or, as they become exhausted, turned into the low-pressure line leading to the welding shop.

A word of caution may not be amiss. It is better to buy the manifolds from a reputable manufacturer of welding apparatus than to make them yourself. It will probably cost less in the end. Furthermore, 2000 lb. per sq. in. is rather too high a pressure to trust to the ordinary pipe fitter or pipe fitting.

Certain accessories are desirable. For instance, a gage should be located in the tool room showing the line pressures, so the attendant can have his "eye on the line" constantly. Another useful device is an accurate master gage, so the pressure on the line can be observed during the noon hour or at least every week-end to test for pressure correctness and for system leakage. A main line valve should be placed outside the building where the fire department can arrange to have it closed in event of an alarm.

Oxygen Piping

Oxygen piping should be designed for 100 per cent overload at any station. This will take care of unusual demands for plant expansion. It should also be capable of delivering 2000 cu. ft. oxygen per hour at 100 lb. per sq. in. at the furtherest point from the manifold. Evidently such a layout should be made by competent engineers.

In an open hearth a pipe line should be carried along both sides of the craneway spanning the bay in which the steel ladles are handled. These lines are carried along the crane columns, high up under the roof trusses, or outside the building just under the eaves. This removes them from the possibility of damage from furnace breakouts or bad spills of metal and brings them above the grease dripping from crane girders. At appropriate places between each pair of furnaces and at each pouring platform a ¾-in. pipe leads

down the building column, stopped by a ¾-in. high pressure globe valve at about 5 ft. from the floor, and ends in a special coupling for the oxygen hose. These outlet valves should be locked and keys kept in possession of responsible workmen only. This guards against waste as well as dangerous uses. Furthermore, oxygen lines should be painted a distinctive color, for example, green, to inform pipe fitters and other workmen of the contents. A metal tag should be chained to each outlet, plainly indicating that the line carries compressed oxygen.

Since oxygen is a valuable commodity, the piping should have welded joints throughout. The need for a permanently leakproof construction is more than ever necessary when the line is supported on mill buildings, which vibrate violently at times, or when crossing made ground, subject even to slight settlement. Some screwed or flanged fittings will be necessary at valves. It would be well to make up these joints in a pipe shop, the threads being thoroughly washed in a solution of 1 lb. of caustic soda to a gallon of hot water. Regular pipe compounds should be prohibited on oxygen lines on account of the oils they contain. Instead of red or white lead a mixture of litharge and glycerine may be used on the male connection only. Valves should also be completely dismantled, washed in hot caustic solution, and on reassembly the original packing replaced with asbestos yarn. Needless to say, all line piping should be washed inside and out with caustic soda before welding the joints, and handled with clean hands and tools and with great care to keep the work clean. After erection the whole system should be flushed out with caustic solution, then put under oxygen pressure twice the working value, and every joint and valve examined for leakage with ivory soap water.

All piping and valves should be new, extra strong, for high pressure, and free from scale or rust. Minimum size should be ¾ in. At suitable points a safety device should be installed to relieve excessive pressures. The pipe should be carefully graded and drip pots welded into the line at the low spots. These should be drained periodically.

With such a piping system, the safest way to handle oxygen about steel plants and foundries will be attained. Oxygen will be delivered where it is needed in a convenient way, like electricity, water, steam or any other liquid or gaseous commodity. It will be protected against misuse by the ignorant and careless. The plant cylinder handling problem will disappear. All risk of cylinder accidents due to furnace breakouts or splashes of hot metal will vanish. The temptation to use oxygen cylinders for rollers, to pitch them off platforms, or kick them around indiscriminately will be practically removed. All these factors have real value to the safety engineer. A clinching argument to the manager rests in the fact that at the same time real economies in oxygen consumption will surely follow.

Simplifying the Design and Construction of Industrial Buildings

D. C. McGiehan†

Wherever land is cheap the tendency is to keep machinery close to the ground and move the materials under process in a more or less horizontal direction. In congested areas, however, or in cases where the force of gravity is of distinct aid to the process it is often more economical to house the operations in buildings several stories in height. Then the materials under process may be elevated once and dropped from machine to machine or tank to tank as the case may be.

This use of vertical handling through a building of several stories involves three major considerations, viz.: control of operations, supervision of operations, and lighting. These problems can probably best be taken care of by eliminating floors in the building.

Of course, it is necessary for the men to work on various levels, so floors are replaced by runways or balconies wherever needed. (Figs. 1 and 2.) These permit observations of various units of equipment from almost any part of the building at all times. They permit the driving of all machinery from main shafts located on the ground floor. And they make a much lighter and more airy building. Furthermore, if the design and construction is handled in the right manner, it is much less expensive. But if a complete detailed layout including structural framing, machine and tank supports, hoppers, chutes, conveyors, runways, stairways, etc., were attempted, it would mean an expensive and arduous task. Furthermore, the erection would be quite difficult.

On the other hand, a diagrammatic layout showing the desired location of the heavy machinery and tanks is a comparatively simple problem. From this the main structural features, such as columns and trusses, can be ordered from a structural fabricating shop. Then the building shell can be erected, and machinery, conveying equipment and other installations made by the engineering department of the plant itself. No detailed drawings are necessary when the oxy-acetylene process is so used.

Several buildings of a large chemical plant were built in this manner. The walls are of brick or reinforced concrete, while the columns are built of steel sections, and in some buildings fireproofed with concrete. The girders and the floor beams which carry the balconies or runways, are "I" sections and the runway flooring is of reinforced concrete slabs. Of course, plans for these should be made by an engineer to insure proper strength.

Putting Up the Steel

The steel work of these buildings with the exception of trusses

†Publicity department, Union Carbide Sales Co.

and heavy columns was fabricated on the job largely with the aid of the oxy-acetylene process. Because second-hand steel was used a lot of fitting was necessary. This was readily done with the cutting blowpipe. Column splice plates were cut, clamped to the columns, and rivet holes cut through both simultaneously.

In securing girders to columns, the girder was swung and blocked in its proper location, butted against the column. Bearing and clip angles were then clamped in place and all the holes for rivets necessary to the connection were cut with the blowpipe.

Where ends of floor beams carrying runways across adjacent

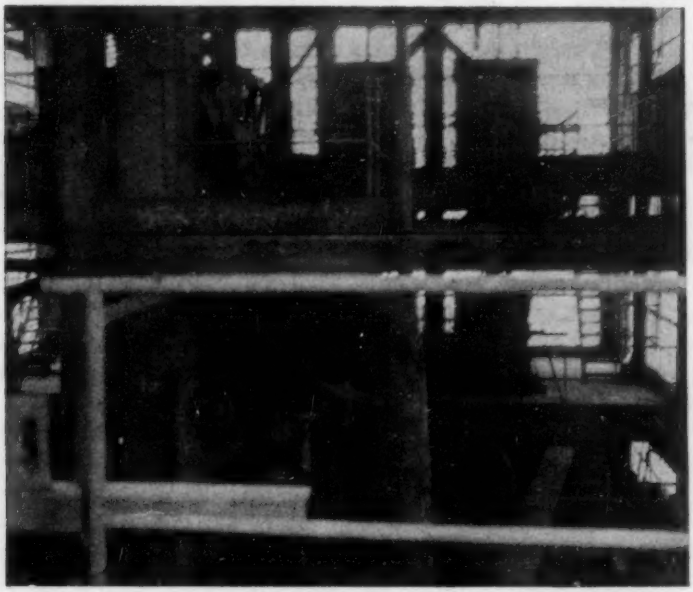

Fig. 1—Balconies and runways placed wherever needed

bays butted into the web of a girder they were connected thereto by riveting through clip angles, the rivet holes being cut at the time of erection.

Where floor beams were carried on top of girders they were merely laid in place and holes cut in their webs at the butting ends, permitting them to be bolted together with a splice plate also drilled with the oxy-acetylene flame. They were then secured to the girder by bolts running through their bottom flanges and the top flanges of the girder. (It is seen that much of this work in steel was done as the old-fashioned millwright would erect the timberwork of a building.) Posts and beams were cut to fit, erected in place, and connections made on the spot. This removed the necessity for detailed drawings for every member—the only diagram necessary was the orginal layout carrying the dimensions and location of the main columns, the spacing and size of the va-

rious floor beams, and the location of machinery and conveying equipment.

Runways and Balconies

The runways and platforms used to replace floors in these buildings are of reinforced concrete slab construction held by I-beams or channels. They are shown in Fig. 3. The beams were erected in this manner:

In those places where channels were used they were placed inward, to facilitate securing the wooden forms for runway floor

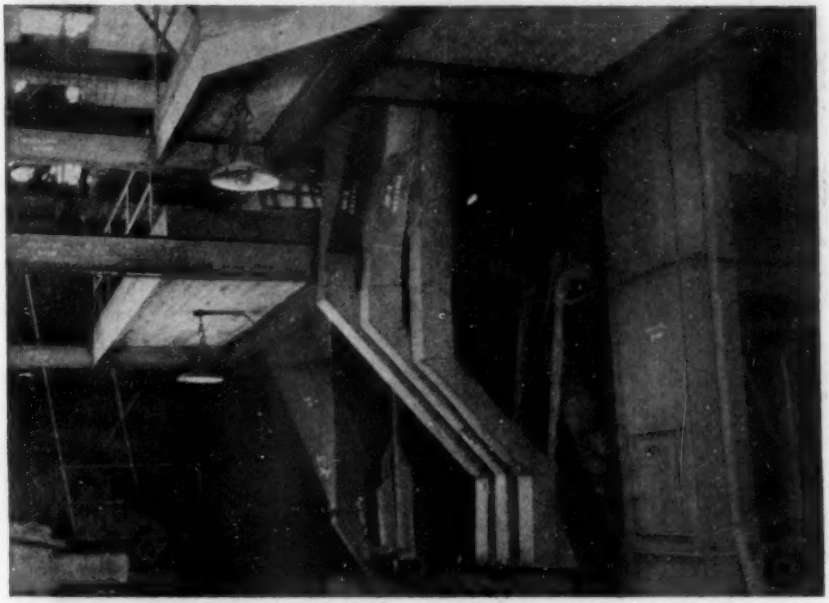

Fig. 2—Chutes built in place by welding

slabs. Next, 1-in. pipe stanchions for railings were welded at even spacing to the top flanges. (A stock of these are always kept on hand—1-in. pipe cut into 3-ft. lengths.)

Then the forms were erected and the runway floor slabs poured. When this concrete had set, the railings of the runways were completed. This was done by welding odd lengths of 1-in. pipe previously joined by welding the tops of the stanchions already located. The middle rail was then put in by cutting pieces of pipe to fit between stanchions (with the cutting blowpipe) and welding in place. (It is interesting to note that the pipe used for this purpose was all second-hand material.) The runways were completed by welding sheet steel toe boards to the stanchions.

Stairways

The construction of stairways in this plant presents another very interesting application of the oxy-acetylene process. They

are all made in the same way, the only difference being in the use of the stringers.

On some, channels were used, while on others 3-in. pipe served this purpose. Clip or bearing angles were riveted to the channel stringers to carry the steps, all rivet holes being drilled with the oxy-acetylene flame. Then short pieces of 8-in. channel laid on these, flanges up, were tack-welded to them. The channels were then filled with concrete containing some steel turnings, making a slip-proof surface resistant to wear. Of course, these stairways

Fig. 3—Note the welded stirway, balcony and belt guards

are equipped with hand railings attached and constructed of pipe in the same manner as those on the balconies.

The second type of stairway, that using pipe for its stringers, is much simpler in construction and probably just as serviceable. It is pictured in Fig. 5. Note that the pipe stringers have been slotted so that the step channels can be fitted into these slots and welded to the stringers. All the work was done with the oxy-acetylene blowpipes.

Putting Up Electric Conduit

To drill the flanges of beams, and then to tap these holes for the screws of pipe straps to hold electric conduit, is tedious work, so this company tack-welded their conduit to the structural framing of the building. This method was every bit as satisfactory as far as holding it in place is concerned and very much more satisfactory as far as convenience and economy are concerned. Further-

more, cross arms for wiring of all sorts are easily made of 2-in. pipe, holes cut for bolting to the pole, and iron pins welded in proper place for insulators. Towers and outdoor switching stations, all welded, are found at this plant.

Chutes and Hoppers

Chutes and hoppers always present a problem in chemical plants, particularly when they are fabricated from sheet metal. It is bad enough to work out a sheet metal development so that the edges meet, but when lap has to be allowed for riveting, all sorts of diffi-

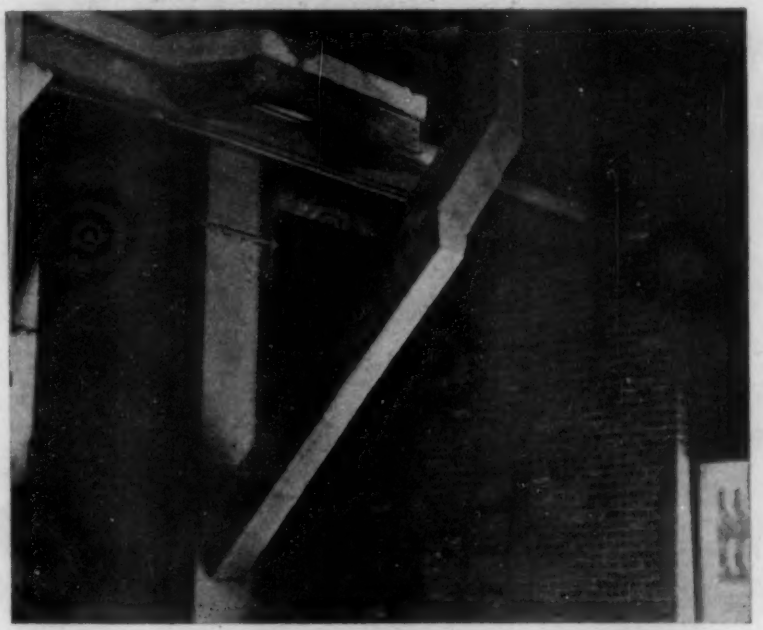

Fig. 4—Another complicated chute

culties are run into. Then, too, riveted points tend to pass such fine material as carbon black. Probably the easiest and most economical way of putting up hoppers, chutes and conveyors, particularly when they are constructed of second-hand material, is to fabricate all straight runs in the central welding shop, then rig them in place and fit joints with the aid of a cutting blowpipe. Take, for instance, the chutes pictured in Figs. 2 and 4. The number of twists and turns would make them a pretty difficult layout, but give a good steel carpenter his welding and cutting blowpipes, plus some sheet metal to work with, and a neat serviceable job is completed in quick order.

An interesting method of stiffening sheet metal is illustrated in Fig. 7 which pictures a portable hopper. Pieces of 1-in. pipe are

slit with the cutting blowpipe, then driven down over the edge of the sheet and welded to it.

An ingenious floor trap for dirt removal which might be classed under the head "Chutes and Hoppers" is shown in the sketch, Fig. 8. It consists of a rectangular box of channels, flanges out, equal in depth to the depth of the floor and cast in the concrete floor. An inclosed chute leading to a waste material conveyor is welded to the bottom of this while the top is covered by a sheet steel door. When the floor is swept it is merely necessary to open the door of this trap and push the sweepings into the chute. Little conve-

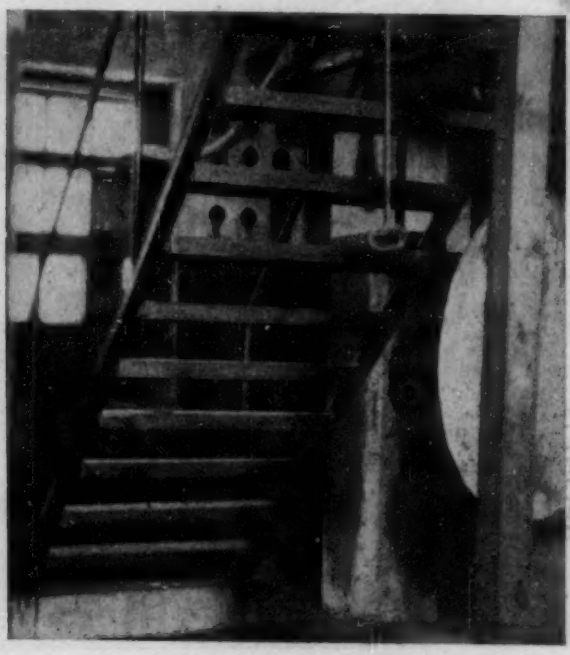

Fig. 5—A pipe and channel stairway

niences of this sort cost very little to install (being made from scrap materials) and help a great deal to keep labor expenses down and plant efficiency up.

Guards

Now take a conveyor or belt guard, and we have something that can be very elaborate or very simple. Note the one pictured in Fig. 3. It consists of nothing more than four longitudinal members of pipe with struts, also cut from scrap pipe, spaced at regular intervals and welded to them. When this is covered with a good stout wire, tack-welded on, we have a guard that is strong and cheap, and can be built by almost any plant welder. The particular one pictured has a door to permit getting at the belt. This was easily made by tack-welding some wire mesh to a frame made

from rather stiff, stout wire, say ¼-in. Then this door was swung from hooks welded to the upper horizontal of the guard frame.

Supports

Another structural feature handled by the oxy-acetylene opera-

Fig. 6—All the iron work is welded

tors of this plant is supports in the form of short columns, used for supporting tanks, stills, machine platforms and so on.

In order to make these, a piece of second-hand pipe of sufficient

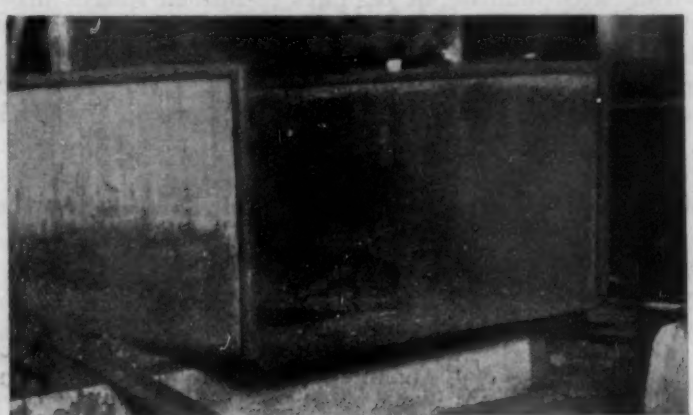

Fig. 7—Pipe welded over edge of sheet stiffens hopper

size to carry the load is cut to correct length with the blowpipe. Then pieces of plate cut to size and shape to act as footing or bearing plates are welded to the ends, making a sturdy and eco-

nomical support. A simple jig for holding the plates square to the center of the pipe during welding is of value. Large bearing plates may evidently be reinforced by brackets, welded in.

Roof drainage about chemical plants—or for that matter in all industral centers—causes much trouble with gutters and down spouts. Ordinary galvanized metal lasts hardly a single season. At this plant, gutters were made of 4-in. pipe, split in half with the cutting flame, welded end to end. Down-spouts and leaders were old boiler tubes, welded throughout. These will stand for years without requiring attention or repair.

Window frames and sash were also made by the torch out of

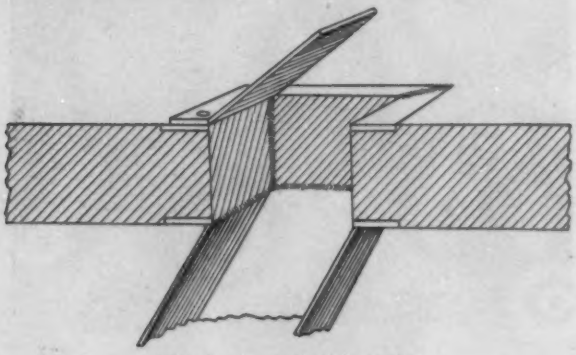

Fig. 8—A good dirt catcher

scrap structural shapes. Strips of channel iron, with depths equal to the thickness of the brick wall, were cut on a miter, and welded together, flanges out, to form the frame. Sash were made of small angle iron, with muntins of tee bars or special shapes procurable from steel mills. Such sash can be made to swing in any manner by cutting appropriate holes in the frame to match pins welded in the sash axis. They serve every purpose, and in fact are made in the same manner as the best metal windows on the market.

Door Frames

Door frames and metal fire doors are made in exactly the same way. In the plant under description, no effort was made to approximate the molded effects attained as a matter of course in all-welded metal frames used in residences and public buildings, since the results attained by ordinary labor using nothing but scrap metal were eminently satisfactory.

While a welding torch is seldom thought of as being useful in foundation work, it is the handiest thing in the world if a trench or pit runs into some disused iron or steel work which must be removed. It is very nearly invaluable in making metal forms.

A special application of the latter is used if really water-proof elevator boots or pits are desired. They can most easily be constructed in this way:

A steel tank is welded, watertight, of exact shape for the outside form. This is painted and sunk into the hole. Then the inner forms of wood are set and some rich concrete cast and carefully tamped in place.

This makes a permanently water-proof pit. The steel will re-

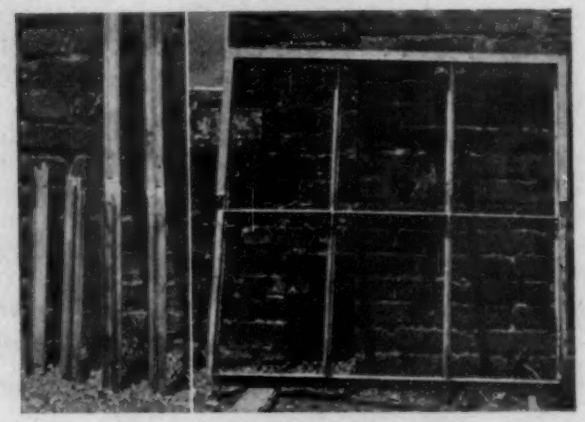

Fig. 9—Window sash are also welded

main watertight for years, but if it finally rusts away, the ground water will find a tight concrete wall, having been cast under ideal conditions.

And so with all the necessary structural features of a large plant; whether they be large or small, the oxy-acetylene blowpipes can materially aid their development and erection. It is almost impossible to look in any direction in any part of a plant without seeing something upon which the blowpipes can be used to advantage. The oxy-acetylene operator is to steel construction what the carpenter is to wood.

Elements of Good Welding*

E. P. JESSOP†

I have found that welding naturally divides itself into two or three phases—*the first phase being the development of machinery for welding*, and this phase has been pretty well thrashed out and established and the methods used by the various manufacturers of welding equipment are more or less well established and a great deal alike.

The second phase, or it might be better to say—*the second department of welding*, takes in the *supervisory personnel;* and *the third department* is, of course, *the operator*.

I have found in my work that the greatest lack in organizations

*Presented at the January meeting of the Northern New York Section, A. W. S.
†Consulting engineer.

which are attempting to apply welding is usually in *the supervisory force* and *not in the actual welding force.*

In the earlier days in the Navy in training men to be gunpointers or gunlayers, we required the gunpointer to do a great deal too much and to shoulder too much responsibility. He was not only required to do the manual labor of training his gun on the target, but in addition he was required to make his own sight adjustments, to estimate his own range and to make his own range correction by watching the fall of the shot.

When we finally began to study gunfire seriously we found that it was not the province of the gunlayer to make his own corrections and adjust his own sight, and that if we were to be successful in accurate fire, it was necessary to give the gunlayer but one job and that was to keep his gun pointed at the center of the target. This segregation was necessary on account of the amount of concentration required in a gunpointer to keep his gun on the target, and, therefore, there came into being the range-finding and site-setting corps, entirely relieving the gunlayer of any need of that responsibility with regard to these adjuncts of gunfire.

An exactly similar situation comes up in the practical application of welding.

A welder in order to do good work must concentrate on the application of the arc, leaving to the supervisory force such matters as—the methods to be used in applying the arc so as to relieve stresses and strains, and to get the major strength into a weld. The supervisor of welding should lay out how the work is to be done. He should be responsible for choosing the metals that ought to be used in the work and the method of the application of those metals. He should also, within limits, prescribe the heat to be used, leaving to the welder the close adjustment of the machine to get proper penetration. If there is no proper supervision, it will very soon be found that welders are using 200 amperes where they should use 130 amperes, and when one remembers that the welding heat for one weld may not be nearly the welding heat for another job, it is palpable that leaving such an important item up to the vagaries of the welder is bound to run into a great deal of trouble. The supervisory force should give the welder sufficient information as to the reason for using the methods prescribed so that the welder can intelligently carry them out, and in all my work I have never found lack of interest on the welder's part after proper explanation has been made, although, of course, at times one will find welders who are too hard-headed to permit anyone to tell them how to make a weld. In such a case the only thing to do is to get rid of the welder.

The third department, that of the operator, has to my mind, been given too much importance in the average statements which are made about welding. One hears so frequently that the efficiency, or inefficiency, of a welded joint is entirely controlled by the ability

of the operator. Such a statement, I believe, to be entirely wrong. With proper supervision and proper standardization of method the ability of the operator becomes of much less importance, the only real requirement then being that he shall be the man to do what he is told and to take sufficient interest in his work as to prevent carelessness. In other words, a perfectly good welder, if not properly instructed by a proper supervisory force, may fail on a weld no matter how hard he may attempt to accomplish it, whereas if he has been informed as to what methods to use to obviate the difficulties of the particular job in hand, it becomes then a simple matter for him to accomplish his work.

A welder should know the following things:

First—What his arc should act like when the heat is properly adjusted, and this is a combination of the action of the arc, as far as its physical characteristics are concerned, and also the amount of penetration it is making in the parent metal. He should know that it is easy to adjust his machine to a low heat and then bring it up, by trial of the arc, to the point where he gets proper penetration, for it is an absolute fact that the lowest current value which will give you proper penetration is the current value to use. A welder also should know that he cannot make a good weld without having the metal surfaces clean and this becomes increasingly important in the case of a built-up weld. Most welders are satisfied to attempt to keep the surfaces clean with a wire brush, but I have found that this cannot be done in the case of a built-up weld, since the slag which is naturally formed by contact with the air and will always be found on the surface of a bead, can only be removed by the hammer; therefore, each layer of a built-up weld should be thoroughly hammered on its surface to remove this coating of slag before the second bead is applied.

This hammering of the weld has also two other advantages—one being that it relieves somewhat the stress set up by cooling—and the other is that hammering the metal increases its tensile strength. I have found that it is very necessary that the supervisory force insist on this hammering of the metal, because the average welder, as I said above, is prone to depend on the wire brush.

In all that I have said it must be remembered that I am talking about 100 per cent welding, and I am not talking about the many uses for welding in the commercial world where full strength in the weld is not required. In many cases only a small part of the full strength of the metal is necessary, and in these cases the welding may be done much faster and many of the niceties of method, of which I have spoken, are not used, but it is not necessary to go into that further because anybody can do welding of that sort.

In the welding of large storage tanks, it must remembered that the strength joints are the vertical joints. In joining the ends of the plate there are three joints which may be used; those are—

first, the lap joint welded on both edges of the lap—second, the double "V" joint—and third, the single "V" joint welded through to a butt-strap and the butt-strap then welded around its edge. These are all joints of about equal strength and should all run over 90 per cent in strength. In making these strength joints, no larger electrode than 5/32 should be permitted. I know that some of you will take exception to this, for I know that you consider that with good welders a 3/16 electrode is all right, but when you consider that the extra diameter of the electrode means that much extra length of arc, due to the fact that the globule of depositing metal is that much larger, in order to prevent freezing of the work you have to hold a longer arc and this in itself causes extra oxidation. In addition, the area of cross section of the 3/16 electrode is great enough to permit the arc to "wander" sufficiently to prevent the welder being able accurately to follow the line of juncture and this following of the line of juncture in a joint is a very important point in a good weld.

However, in the horizontal joints on the edges of the plate and in field storage tanks, these joints should all be lapped and it is possible to speed the work up by the use of the 3/16 electrode as these joints are not essentially strength joints as in the case of the vertical joints. The bottoms and the roofs of the tanks should be welded with a 5/32 rod, for in these joints, from the nature of the case, you only have a single weld on one edge of the lap and it is essential that these joints be gas and oil tight and with the thickness of metal usually put into the bottoms and roofs you cannot get a tight joint with a 3/16 rod.

In conclusion, let me say that the reliability of welding is well within practical limits of accomplishment, and in the things which I have said I have attempted to name a few elementary principles which are necessary to insure good welding, since my experience has been that when these are followed, absolute reliance can be placed on the weld.

Discussion of Papers

Discussion of paper "Reclaiming Worn and Broken Parts of Machinery" by T. T. Copeland, appearing in the December, 1924, *issue of the* JOURNAL.

W. Spraragen. In the paper referred to above, the author, Mr. T. T. Copeland prepared an excellent review of the possibilities of reclaiming worn and broken parts of machinery by the use of welding.

There is, however, one item which requires further consideration in my opinion. Mr. Copeland gives the results of some comparative tests on samples made by welding with bare wire and covered wire. These tests show up very much in favor of the bare wire electrodes.

I have noted in a number of papers where such comparisons are

made that the relative merits of the two wires show up differently, depending on how the test samples were made up. For example, if the welding was done over in England or France invariably the flux covered wire shows up better than the bare wire. In most instances this can be attributed to the fact that the operator who made up the samples was experienced in welding with flux covered electrodes but had little or no practice in welding with bare wire. Moreover, in many instances the bare wire being tested is of inferior quality to that of the flux covered wire. It is not very surprising, therefore, that under such circumstances a flux covered wire should show up better.

Where the tests are made in this country almost diametrically opposite results are obtained in that the bare wire generally is found to be better than the flux covered wire. Here again I have found that in most cases the operator is skilled with the use of bare wire but has had very little experience with flux covered wire and in many instances the flux covered wire is not a standard recognized material, such as can be obtained from reliable manufacturers of flux covered wire.

T. P. COPELAND—Mr. Spraragen brings up an excellent point in regard to these tests. In our case the welding operator had had previous experience in the use of the flux covered electrodes and is considered a competent man.

The procedure in welding was as follows:

A piece of boiler plate ½ in. x 24 in. x 24 in. was cut through the center and both sides to be welded were veed to about 45 deg., then welded by first welding a bead through the entire length of vee, then the opposite side welded, then finished the other side; this held the plate straight; the plate was then machined to sizes of ½ in. x 2 in. x 24 in., thus giving an equal area.

Mr. Spraragen also inquires as to the reasons why one specimen showed no load. A small part of the weld at the point of fracture showed small craters but not of sufficient quantity to cause it to fracture. Our chief metallurgist can give no definite reason for the behavior. The superiority of the bare wire over the flux-covered wire in my opinion is due to the physical and chemical characteristics of the wire and I have no doubt that if both wires had been of the same composition that the ultimate strength would be equal if not greater with the covered wire. The wires used were of the following composition.

No. 1	Flux Coated	.....	.03 Carb.	.11 Mang.	.010 Phos.	.037 Sul.
No. 2	Flux Coated	.....	.06 Carb.	.12 Mang.	.010 Phos.	.038 Sul.
No. 3	Bare Wire	.....	.15 Carb.	.51 Mang.	.035 Phos.	.041 Sul.

Mr. Spraragen mentions that the difference in results obtained from the test specimens might be due either to the operator or to the fact that the flux-covered wire was not a recognized standard product. Perhaps the welding wire was not as good as it might

have been, although the operator was skilled in the use of flux-covered electrodes. As a matter of explanation why the specimen marked 1-a broke in the weld, as shown in the table below, was due to the fact that the operator did not have a perfect weld at the bottom of the vee about ⅜ in. and near the edge which caused the specimens to break in the weld.

Record of Physical Tests

Approximate width of specimen, 2 in.
Approximate thickness of specimen, ½ in.

Spec. No.	Ult. Tensile Strength, Lb. per Sq. In.	Per Cent Elongation in 8 In.	Per Cent Reduction in Area	Remarks
1	59,420	24.5	51.5	Broke outside of weld A
1[a]	58,260	9.0	52.5	Broke in weld
2	59,400	23.0	52.2	Broke outside of weld
2[a]	58,780	26.5	51.0	Broke outside of weld
3	59,400	21.0	52.9	Broke outside of weld
3[a]	59,600	23.2		

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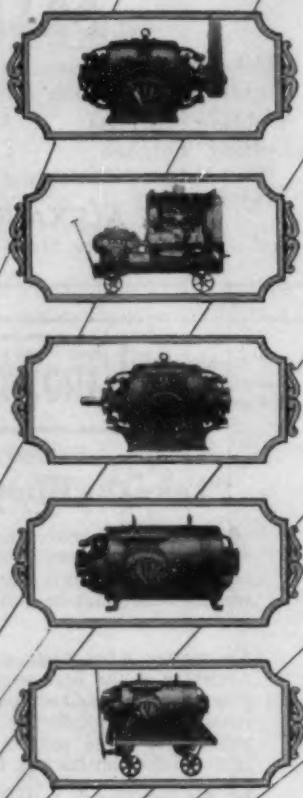

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224 No. Carpenter St. Chicago, Ill.

UNION CARBIDE

World's Best Quality - Highest Gas Yield
Always Uniform - Always Dependable

Packed in Blue and Gray Drums

We have Warehouses in 175 Cities

The product of the originators and developers of the carbide and acetylene industry

QUALITY assured by more than a quarter of a century of experience in selecting raw materials and in perfecting laboratory practice and works processes.

The faithfully sustained quality compels recognition of the economies which go with it.

Union Carbide will keep for years in the original package without deterioration.

Our remarkable nation-wide service and distributing system makes Union Carbide quickly available everywhere.

There is a Union Carbide warehouse near you. Shipment is made same day your order is received.

We supply Union Carbide in Generator sizes—direct to consumer—at factory prices.

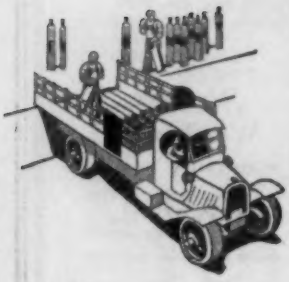
Our Blue and Gray Drum is recognized throughout the world, as a symbol denoting Best Grade Carbide, Highest Gas Value, Uniform Dependable Quality and Purest Gas.

UNION CARBIDE SALES COMPANY

Principal Offices: Carbide and Carbon Bldg., New York, N.Y.
Peoples Gas Building, Chicago, Ill. Balfour Building, San Francisco, Calif.

"This phase of our service will be recognized"—

wrote a vice-president of the Linde Company six years ago



IN RECOMMENDING that the Linde Company enlarge its service to include the giving of help to Linde customers in their use of processes requiring Linde oxygen, this vice-president wrote six years ago:

> "This phase of our service can, I am confident, be developed to such an extent that, in the course of time it will be recognized by a large percentage of the users of our products as an important factor in the oxy-acetylene field, and will be called upon freely for advice in small as well as large matters."

Time has proved the soundness of this prediction. Thousands of Linde users depend upon Linde Process Service to increase their profits from the use of Linde oxygen. Moreover, the fact that practically all oxygen manufacturers now offer service of this kind indicates that the whole oxygen industry recognizes its value.

Linde Process Service is planned for every Linde user. It reaches out into the shop where but one blowpipe is owned to make its use better and more profitable. It goes to the largest industrial organizations to be of help to every one from the welder's helper to the president.

Each individual case challenges the ability of Linde Process Service to quickly and efficiently adapt itself to the size and difficulty of the problem. Successful service in each specific case makes Linde Process Service better and more helpful to all Linde customers.

Linde Process Service is free to every Linde user for the asking

THE LINDE AIR PRODUCTS COMPANY

General Offices: Carbide & Carbon Building
30 East 42d Street, New York

37 PLANTS—80 WAREHOUSES

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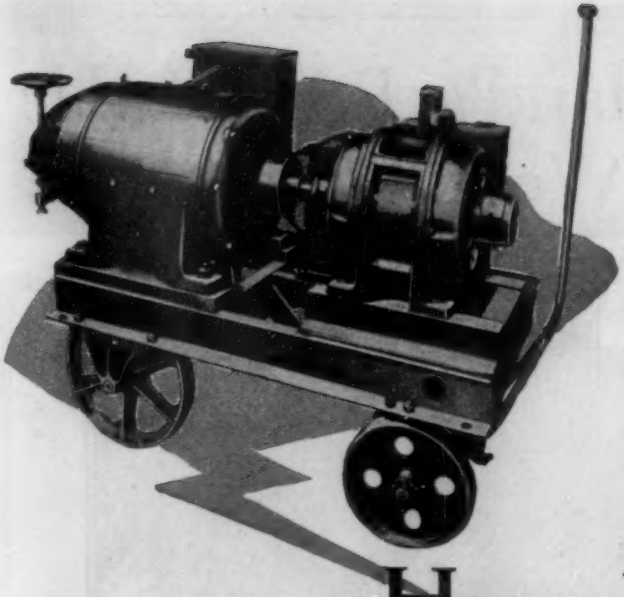
LINDE OXYGEN

YOU CAN DEPEND ON THE LINDE COMPANY



Heavy Duty!

—a feature of the WD-12 Arc Welder

This welder gives 24-hour service, day after day.

It delivers 200 amperes continuously and 300 amperes for short periods. Voltage can be adjusted to suit the work. High voltage is provided to "burn the metal in" on heavy work.

The WD-12 Arc Welder can be used with all commercial sizes of electrodes up to ¼" diameter. It will handle any welding job either nearby or over a thousand feet from the machine.

Ready to work when delivered.

The WD-12 Arc Welder

—operates on any commercial voltage, phase or frequency.

—a two-unit machine (motor and generator).

—generator is self-excited.

—reactor automatically steadies arc.

—handwheel on generator for regulating welding current.

—any value of welding current between 75 and 300 amperes.

—any commercial sizes of electrodes, large or small.

—supplies power to G-E Automatic Arc Welder for continuous welding.

There is a suitable G-E welder for your every arc welding need. Ask the G-E sales office for complete information.

General Electric Company
Schenectady, N. Y.
Sales Offices in all Large Cities

29A-7

GENERAL ELECTRIC

Cleveland's *Remarkable* Welding Job

6,000 *Feet of 16-inch High Pressure Steam Line*

PAGE ARMCO WELDING RODS, used to weld 6,000 ft. of 16" steel pipe, ½" thick, pressure steam line of the Cleveland Electric Illuminating Company, Cleveland.

EACH Welded joint has to stand 500 lbs. test. Five pounds of added metal is applied to each joint.

The welding men naturally chose Page-Armco, the most uniform, easiest flowing, gas-free rods on the market. It saved time—gave them a better job.

Rods are a small part of welding cost. Can you *ever* afford to take chances—use any but the best? Try PAGE-ARMCO, time the job, and inspect it and test it.

PAGE also makes high carbon rods—rods of all types for gas, electric and automatic welding. Write for illustrated folder telling how better rods cut welding costs. No obligation. A card will do.

PAGE STEEL & WIRE CO.

Bridgeport, Connecticut

District Offices, Chicago, New York, Pittsburgh, San Francisco

An Associate Company of American Chain Co., Inc., of Bridgeport

ARMCO Ingot Iron

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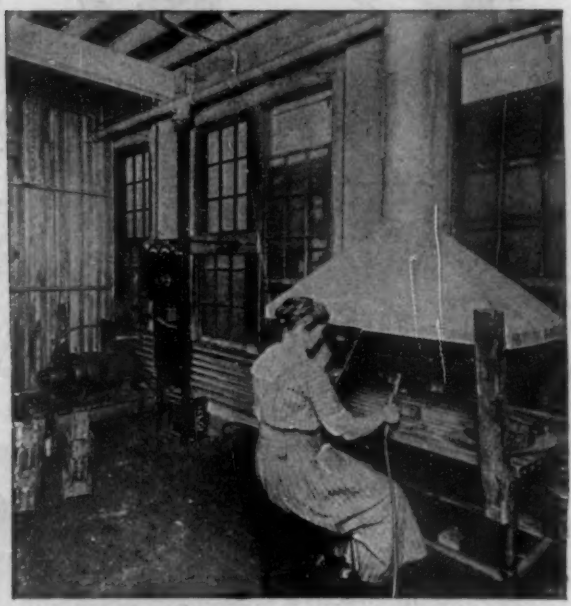
WELDING RODS

LINCOLN ARC WELDER

EASE OF OPERATION



This is the one important thing which a buyer of arc welding equipment should consider.

If the machine is easy to operate that is a certain indication that its electrical design is right. It is further a guarantee that it will work rapidly and make good sound welds. Easy operation always makes for speedy welding and good welding.

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A Bow and Arrow Is a Fine Weapon—If—

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Modern business has no place for out of date, ineffective tools. By specifying

REGO WELDING and CUTTING EQUIPMENT

you are always assured of torches and regulators of the most "modern" construction.

Write for No. 32 Catalog

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ACETYLENE FROM CAKES

Carbic low pressure, portable generator. Weight charged—200 lbs.
Listed as standard by Fire Underwriters' Laboratories.

The most modern, efficient and safest source of acetylene supply—Carbic CAKES.

Not an experiment. Hundreds of Carbic generators using Carbic are in daily use on all kinds of welding and cutting work.

The use of Carbic Cakes permits an ease of handling, a convenience and a safety not otherwise obtainable.

Acetylene from Carbic costs less than one-half as much as compressed acetylene and only a few drums of cakes carried in stock insure a large supply of gas on hand at all times.

THE Carbic SYSTEM

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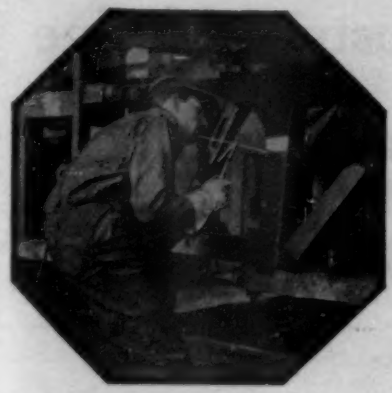

ROEBLING WELDING WIRE

High Carbon Electrodes
Low Carbon Electrodes
Gas Welding Wire

Conforms to specifications of The American Welding Society

Exacting tests have proven that it possesses those qualities essential to good welding.

John A. Roebling's Sons Company
TRENTON, NEW JERSEY

Style P Helmet

CESCO ARC WELDING HELMET

Style P. A thoroughly practical and comfortable protection for the welder. Note that when preheating or making the work ready the door indicated by the arrow, at the left, opens up, and back of this door is a protection glass. Thus inspection of work is made convenient and free from the danger of filling the operator's eyes with sand.

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2304 Warren Ave. Chicago, Ill.

THERMIT WELDING

For heavy welding operations in all fields

Railroad Industrial Marine

METAL & THERMIT CORPORATION

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"THE UNIVERSAL WELDING MACHINE"

The Only Really Portable Machine

ARE YOU AWARE that our machine can be made to operate from any INDUSTRIAL POWER SUPPLY A. C. or D. C.

Electric Arc Cutting & Welding Co.

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Dependable Welds Require Dependable Equipment

Under the most severe service conditions these machines have demonstrated their mechanical and electrical fitness.

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High Purity Oxygen

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Airco high purity oxygen can be bought that way. Why buy oxygen any other way?—we prefer to sell it on that basis.

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Anything and Everything for Oxyacetylene Welding and Cutting

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